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# Treatment Tips for Fish Producers

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By Andrew J. Mitchell
Fred P. Meyer

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# Treatment Tips for Fish Producers[1]

by

Andrew J. Mitchell and Fred P. Meyer[2]

*U.S. Fish and Wildlife Service*
*Fish Farming Experimental Laboratory*
*P.O. Box 860*
*Stuttgart, Arkansas 72160*

## Introduction

Fish disease treatments are seldom straightforward. An understanding of the volume and condition of the water, the species and age of the fish, the activity of the chemical, the intensity of the disease outbreak, and the rate of treatment, as well as other factors, is important in obtaining consistently beneficial treatment results.

In this leaflet, we define many of the variables to be considered when the producer is treating fish diseases, and offer information that should help make treatments safe and beneficial.

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[1]Revision of leaflet RP-66, formerly F&WS Circular 209 (1968), "Treatment Tips," by Fred P. Meyer.

[2]Present address: U.S. Fish and Wildlife Service, National Fisheries Research Center, P.O. Box 818, LaCrosse, Wis. 54602.

## Need for Treatment

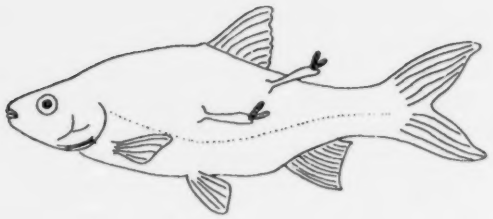
The most beneficial "treatment" is the one that does not have to be given because the producer has taken steps to avoid the disease problem before it can develop. Although prevention is effective in dealing with many diseases, some require treatment.

When a disease problem occurs, sick fish should be taken promptly to a qualified diagnostician. It is best not to begin treatment until the cause of the problem has been determined. It is important that the selected treatment be effective and safe, to reduce costs and avoid financial losses.

After a diagnosis is made, several other factors should be considered. Are the fish too near death to be saved? Does the extent of the mortality justify the expense of treatment and labor involved? Is the infection likely to spread to other fish stocks if treatment is delayed or withheld? Does the nature of the disease and size of fish preclude the immediate processing of the fish? These and other similar questions should be answered before any treatment is given.

## Chemical Selection

If benefit is to be gained from a treatment, the chemical used must be effective against the pathogen and nontoxic to the fish. Water quality and temperature greatly influence the effectiveness and toxicity of certain chemicals. In a pond with a heavy plankton bloom, potassium permanganate may not be cost effective, whereas in clear water it may be the chemical of choice. An otherwise safe copper sulfate treatment may prove to be toxic in rain-softened waters. To ensure safe, effective treatments with copper sulfate, one must know the total alkalinity.



Temperature is an important factor in using Masoten to treat body flukes: It is usually effective at 70° F, but is broken down so rapidly at 85° F that it does not remain in the water long enough to be effective.

## Treatment Rates

Inasmuch as fry and small fingerlings often cannot tolerate chemical dosages that are safe for larger fish, it may be necessary to use lower rates in treating young fish. Chemical tolerances also differ among fish species. For example, the tolerance of potassium permanganate is higher in golden shiners than in channel catfish. Also, fish that have severe parasite infestations are less tolerant of treatment chemicals than are fish with few parasites. If fish reduce feeding because of a bacterial infection, it may be necessary to use the strongest allowable concentration of medication in their feed to provide a therapeutic dose; on the other hand, fish that are feeding at a normal rate receive

therapeutic dosages from feed containing lower concentrations of medication.

Water quality factors not only affect the choice of chemical, but also the treatment rate. Copper sulfate, for example, can be applied safely and effectively when the total alkalinity of the water is between 40 and 250 ppm, but the safe application rate rises from 0.3 ppm to 2.0 ppm as the alkalinity increases from 40 ppm to 250 ppm.

## Treatment Measures

In fish culture, several units of weights and volumes are used. Most U.S. fish farmers are familiar with the English system of measurement (pounds, acre-feet, gallons, cubic feet, etc.). Occasionally the metric system (milligrams, grams, kilograms, liters, milliliters, or cubic centimeters) is used. Metric units are usually necessary when medications are applied to feed or when treatments involve small volumes of water. When one applies chemicals in small volumes of water, treatment recommendations are often given as grams per gallon, grams per cubic foot, milliliters per gallon, or milliliters per cubic foot. For feed medications, the normal rate is expressed as grams per 100 pounds of fish. In large bodies of water, ounces per 1,000 cubic feet and pounds per acre-foot are used.

The conversion tables given at the end of this leaflet give equivalent values for all of the common treatment measurements mentioned previously.

## Treatment Units

Treatment concentrations applied to the water are usually expressed as parts per mil-

lion (ppm). These terms involve weight-to-weight relations; units of volumes cannot be used directly. Different chemicals have different weights per unit of volume. For example, one cubic foot of lead weighs much more than one cubic foot of water. A quart jar filled with copper sulfate and a quart jar filled with potassium permanganate have different weights. To accurately get a treatment in parts per million, the chemical should always be added by weight into a known weight of water.

One pound of chemical added to 999,999 pounds of water gives a treatment of 1 ppm—1 pound of chemical per 1,000,000 pounds of total mixture. It would be impractical to weigh that much water. However, the weights of various volumes of water are known and, from these, the weights of chemicals needed to provide a certain concentration can easily be calculated. The amounts of chemical needed for a 1-ppm treatment in set volumes of water follow. (Where the chemical weight is too small to be expressed in pounds or ounces it is given in grams or milligrams.)

One part per million equals

2.7 pounds per acre-foot
1.0 ounce per 1,000 cubic feet
0.13 ounce per 1,000 gallons
3.78 grams per 1,000 gallons
28.35 grams per 1,000 cubic feet
0.0283 gram per cubic foot
0.00378 gram per gallon
1.0 milligram per liter

For treatments incorporated into the daily ration of the fish, the treatment rate is based on body weight, because medication is prescribed according to the weight of the fish. Standard units of treatment are given in grams of drug per 100 pounds of fish per

day. If 100 pounds of fish are to be treated with Terramycin at the rate of 2.5 grams per 100 pounds of fish per day, the amount of feed offered each day must contain 2.5 grams of pure Terramycin. Fish are generally fed at the rate of 3% of their body weight per day. At this feeding rate, 3 pounds of feed are fed each day to 100 pounds of fish. If properly prepared, the 3 pounds of feed contain 2.5 grams of Terramycin; and 100 pounds of feed should contain $100 \div 3 \times 2.5$ grams, or 83.3 grams of Terramycin. A ton (2,000 pounds) of medicated feed to be fed at a 3% feeding rate would require $2{,}000 \div 100 (= 20) \times 83.3$ grams = 1,666 grams of pure Terramycin. The medication concentration required by higher or lower feeding schedules can be adjusted by substituting the actual feeding rate for the 3%.

## Active Ingredient

Some chemicals are not pure compounds—that is, they contain less than 100% active ingredient. The percent of active ingredient in a product is shown on the label. Treatment rates, unless otherwise stated, are based on the active ingredient only. If 2.7 pounds of a pure chemical per acre-foot gives a 1-ppm treatment, more than 2.7 pounds will of course be needed if a product contains less than 100% active ingredient. A formulation such as Masoten contains 80% active ingredient. The equivalent amount of active ingredient contained in a pure compound is determined by multiplying by 1.25 (100% ÷ 80%). By dividing 100% by the percent active ingredient, the multiplication factor needed can be derived for any formulation.

Chemicals also come in liquid formulations, each containing a certain amount—

often 4 pounds—of chemical per gallon. One pint (1/8 gallon) of such a formulation contains 0.5 pound of active ingredient.

When one treats small tanks with liquid formulations, it may be easier to work with a metric unit, the milliliter. A gallon contains 3,785 milliliters (see conversion tables given later). Thus, a 4-pound-per-gallon formulation contains 1,816 grams (4 × 454) of active ingredient or 0.48 gram per milliliter (obtained by dividing 1,816 by 3,785). This simple computation makes it possible to measure out small weights of chemical by using a measure of volume.

Formaldehyde solution, also known as formalin, contains 37% to 40% formaldehyde gas; for fish cultural purposes, however, it is considered a pure compound. To use formalin accurately, one must know how much a gallon weighs. A gallon of formaldehyde solution weighs about 9 pounds. Since 2.7 pounds per acre-foot yields 1 ppm, each gallon delivers 3.3 ppm (9 ÷ 2.7) per acre-

foot. If the standard 25-ppm formaldehyde pond treatment is made, 7.5 gallons (25 ÷ 3.3) per acre-foot are required.

Premixes used in feed formulations usually contain 25 grams of activity per pound of material. To incorporate 2.5 grams of active ingredient into a quantity of feed when using such a premix, one must use 0.1 pound (2.5 ÷ 25) of premix. One can also express 0.1 pound as 1.6 ounces (0.1 × 16) or 45.4 grams (0.1 × 454).

## Determination of Volume of Ponds, Tanks, and Raceways

Determination of the water volume in a pond, raceway, or tank is critical to safe and effective treatments. One should never rely on an estimate or a guess. Many fish have been killed by overdoses resulting from such procedures.

The volume of water in a tank or raceway is usually expressed in gallons or cubic feet. Volume in cubic feet is computed by multiplying the length by the width by the depth (all measurements in feet). Thus, a tank 40 feet long and 6 feet wide with water 1.5 feet deep contains 360 cubic feet (40 × 6 × 1.5) of water. The volume in gallons can be determined by multiplying the cubic feet by 7.5. A tank with 360 cubic feet of water contains 2,700 gallons (7.5 × 360). Volumes of round tanks can be determined by using the formula: *3.14 × radius (in feet) × radius (in feet) × depth (in feet) = volume in cubic feet.* The volume of a tank measuring 12 feet in diameter and 3 feet in depth would be determined as follows: 3.14 × 6 feet × 6 feet × 3 feet = 339.1 cubic feet. Note that the radius (6 feet) is half the diameter (12 feet).

Most large-pond treatment recommendations are given on an acre-foot basis. To deter-

mine acre-feet, simply multiply the surface acreage by the average depth in feet. An 11.3-acre pond with an average depth of 3.5 feet contains 39.5 acre-feet (11.3 × 3.5) of water.

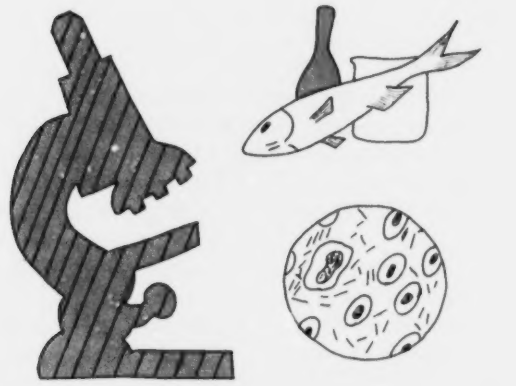
The average depth can be determined by measuring the depth with a weighted line at regular intervals along several transects across the pond. Be sure to measure both the deep and the shallow areas of the pond. The average depth can then be computed by adding all the measurements and dividing by the number of measurements taken.

The area (in square feet) of a pond is determined by multiplying the length in feet by the width in feet. By dividing the number of square feet by 43,560 (the number of square feet in an acre), the surface acreage can be determined. If a pond is 950 feet long by 520 feet wide, it contains 494,000 square feet (950 × 520) or 11.3 acres (494,000 ÷ 43,560). The following formula serves as a useful method for determining the surface acreage of a rectangular pond: *Length (in feet) × width (in feet) ÷ 43,560 = number of acres.*

The surface area of ponds with irregular sides can be determined by using graphing techniques or a planimeter. Fisheries biologists or employees of the Soil Conservation Service can help fish producers determine the surface area (acreage) of their ponds.

## Treatment Methods

The method of application chosen for a particular treatment depends on the disease organism, the fish, the therapeutant, and the size and type of aquacultural unit. Chemicals applied to the water are usually not absorbed by fish and so cannot usually be used for treating internal parasitic and bacterial infections.



Internal or systemic diseases caused by bacteria, tapeworms, flukes, and roundworms are usually treated with medicated feeds. Two considerations related to medicated feed are that (1) the fish may be too sick to feed, and thus, will not receive the required medication, and (2) the disease agents are sometimes resistant to the drugs.

Two other methods of treating internal disease organisms include injection and entubing the medication directly into the stomach of infected fish. Both methods are labor intensive and practical only for use with small numbers of valuable fish.

For external bacterial and parasitic infections, the chemical treatment is added to the water. If the fish are held in small tanks (less than 1,000 cubic feet) that can be rapidly flushed, bath treatments (strong solutions added to the water) of a few minutes to a few hours can be given. However, if fish are held in large ponds where rapid water exchange is not possible, an indefinite treatment (a

treatment applied to the water and left indefinitely) is the only practical procedure.

One of the best ways to apply chemicals to ponds is to use a boat and motor. Dry chemical can be placed in a tightly woven sack and pulled behind the motor of the boat. The chemical dissolves in the water and the propeller aids in its distribution. Chemical solutions can also be spread from a tank in the boat by using a boat bailer or a siphon hose that empties behind the propeller. Large ponds can be treated by aerial application. Small ponds can be treated with hand-held sprayers. Chemicals can sometimes be effectively distributed by placing them in the current of a paddlewheel aerator.

In raceways and tanks, dip or drip treatments can be used. Dip treatments involve very strong solutions to which the fish are exposed for short periods—usually 30 seconds to 1 minute. Extensive handling of fish is involved in dip treatments because the fish must be concentrated at one end of the raceway, dipped up in nets, put into a tub of treatment solution, withdrawn, and then put back into the raceway.

Drip treatments are less stressful than dip treatments but can be more difficult to administer. A drip system must be set up to treat the incoming water at a rate that maintains the desired concentration of chemical. This rate is maintained for the period required for effective treatment.

In developing drip treatments, the following four-step procedure is helpful.

**1.** Determine the volume of water in the unit (raceway or tank) in gallons.

**2.** Determine the amount of chemical needed to treat the volume determined in step 1. (Use the formula given in the section that follows.)

**3.** Determine the number of water exchanges that will occur during the desired treatment time (in minutes). This can be computed by

using the following formula: *Treatment time (minutes) × inflow (gallons per minute) ÷ gallons in unit (step 1) = number of water exchanges.*

**4.** Determine the amount of chemical to be added to the drip system container by using the following formula: *Amount of chemical needed (step 2) × number of water exchanges (step 3) = weight of chemical needed for drip treatment.*

If there are areas of poor water flow in the raceway or tank, a pretreatment with the amount of chemical determined in step 2 may be needed to ensure an effective treatment. This pretreatment is applied directly to the water in the raceway or tank just before the drip treatment is started.

## Computing Treatments

If the volume of an aquacultural unit is known, the weight of chemical to be added can be computed from the following formula: *Volume × ppm desired × 100% ÷ percent active ingredient × desired part-per-million equivalent for unit of volume used = weight of chemical needed.* To compute the amount of chemical to be used, you can begin with any unit of volume; however, in the calculation, you must be sure to use the correct part-per-million equivalent for the unit of volume you are working with.

Four examples follow (for conversions to parts per million, see list in earlier section, "Treatment Units"):

- A tank containing 380 cubic feet of water is to be treated with a 50% active ingredient product at 5 ppm. How much chemical should be used?

It is calculated as follows: 380 cubic feet × 5 ppm × 100% ÷ 50%(=2) × 0.0283 gram per cubic foot = 107.54 grams. The

part-per-million equivalent is the number of grams in a cubic foot that gives 1 ppm. The conversion tables given later show that there are 28.35 grams in 1 ounce. The division of 107.54 grams by 28.35 grams yields the amount of product needed—3.8 ounces.

- A tank holds 430 gallons of water and a 3-ppm treatment of a pure chemical is needed. How much chemical should be added to this tank to yield 3 ppm?

The computation follows: 430 gallons × 3 ppm × 100% ÷ 100%(= 1) × 0.0038 gram per gallon = 4.9 grams. The weight needed to give 1 ppm in a gallon is 0.0038 gram.

- A pond has 42 acre-feet of water and a 15-ppm treatment of formaldehyde is

desired. How many gallons of formaldehyde are needed?

The calculation follows: 42 acre-feet × 15 ppm × 100% ÷ 100%(=1) × 2.7 pounds per acre-foot = 1,701 pounds or 189 gallons. To get a 1-ppm treatment per acre-foot, 2.7 pounds are required. As discussed earlier, 1 gallon of formaldehyde (considered 100% active) weighs about 9 pounds. The division of 9 pounds into the 1,701 pounds of formaldehyde needed shows that 189 gallons are needed.

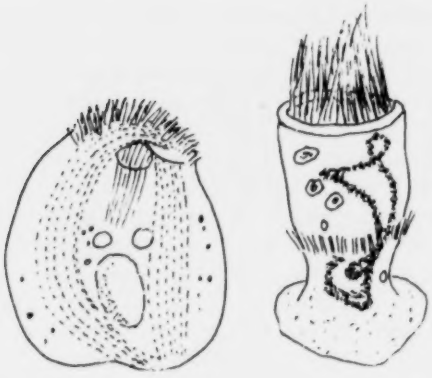
- A pond holding 14,350 cubic feet is to be treated with ½ (0.5) ppm of a 25% active ingredient chemical. How much chemical should be added to the pond?

The computation follows: 14,350 cubic feet × 0.5 ppm × 100% ÷ 25%(=4) × 0.0283 gram per cubic foot = 812.2 grams. The conversion table indicates that there are 454 grams in a pound. The division of 812.2 grams by 454 shows that 1.8 pounds are required.

As a fish producer becomes familiar with making the needed computations, many shortcuts will become apparent. To avoid confusion, we do not include them here.

## Treatment Frequency

How often should fish be treated? This important question can be answered only by determining a pathogen's susceptibility to the compound used, the effect of the first treatment, and the potential for recurrent infection. Some pathogens, such as the anchor parasite or Ich, require several treatments for effective control because part of the life cycle is lived in or below the skin, where external treatments cannot penetrate. Others, such as the protozoan parasites *Chilodonella* and *Trichodina*, usually require only one treat-



ment. To be sure that a treatment has been effective, however, one must make a follow-up examination of the fish about 24 hours after treatment, either by watching for the presence of additional sick and dying fish, or by examining some fish microscopically to check for the presence of the parasite. One should also consider the time of year—protozoan parasite infestations treated in early spring are likely to recur. By late spring, however, the temperature may no longer favor recurrence. Additionally, if a stress factor that was responsible for the onset of a disease has not been removed, the disease is likely to reappear and require more treatments.

## Timing of Treatments

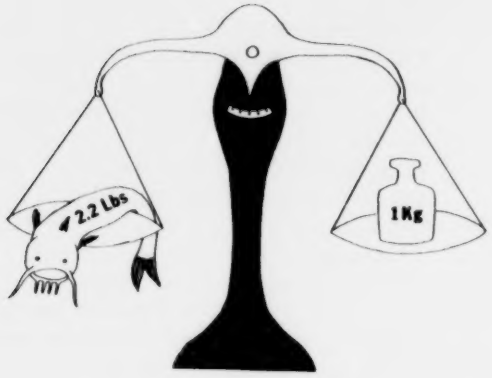
A number of factors, such as severity of the disease, weather conditions, tempera-

ture, the need for daylight application, and the nature of the treatment chemical, must be considered when the producer determines the best time for application. Treatments should be started immediately when serious disease problems such as enteric septicemia of catfish are diagnosed. Because of potential low-dissolved oxygen problems, copper sulfate and formaldehyde treatments should not be applied during cloudy weather in summer. Potassium permanganate should be applied early in the morning so it can be observed throughout the day to determine if additional applications are necessary to retain the wine-red color for 10 to 12 hours. The temperature of the water determines the length of time that the free stages of Ich and the anchor parasite are susceptible to treatment, and also the length of time needed to complete the life cycle. Therefore, the spacing of the treatments depends on the temperature. In summer, Masoten is most effective when applied at daybreak when the temperature of the water is lowest. When the water temperature exceeds 80° F, Masoten has little effect.

## Other Important Considerations

Human safety is always the first thing to consider when one uses fisheries chemicals. Since most of the chemicals are biologically active and some are highly toxic, they should be handled only by people experienced in the handling of dangerous substances. Protective clothing, including masks and gloves, should be worn when chemicals are handled. All labeled precautions should be read and carefully followed.

Chemicals applied should be restricted to those labeled for fisheries use, and administered only at the rates given on the label.




Powders and crystals that are kept cool and dry usually retain their potency for several years. Most chemical solutions should be kept at temperatures above 40° F and below 85° F. Expiration dates for chemicals should be noted, as well as any special storage requirements. All chemicals should be kept in their original containers, tightly sealed and well separated from other types of chemicals. All fisheries chemicals should be stored in a ventilated building that is secure and not accessible by children or animals.

## Conversion Tables

Acre =
- 43,560 square feet
- 4,046.9 square meters

Acre-foot =
- 1 surface acre of water 1 foot deep
- 43,560 cubic feet
- 325,850 gallons
- 2,718,144 pounds of water

Cubic centimeter =
- 1 milliliter
- 1 gram of water

Cubic foot =
- 1 foot high × 1 foot wide × 1 foot deep
- 957.5 fluid ounces
- 7.48 gallons
- 62.43 pounds
- 28,317 grams or milliliters of water

Cup =
- 8 fluid ounces
- ½ or 0.5 pint

Fluid ounce =
- 6 teaspoons
- 2 tablespoons
- 1.043 ounces (weight) of water
- 29.57 milliliters or grams of water

Gallon =
- 128 fluid ounces
- 8 pints
- 4 quarts
- 0.13 cubic foot
- 8.35 pounds of water
- 3,785 milliliters or grams of water

Gram =
- 1,000 milligrams
- 0.035 ounce (weight)
- 1 cubic centimeter
- 1 milliliter of water

Kilogram =
- 1,000 grams
- 2.2 pounds

Liter =
- 33.81 fluid ounces
- 1.06 quarts
- 1,000 milliliters
- 1 kilogram of water
- 2.2 pounds of water

Milligram =
- 0.001 gram
- 0.0338 fluid ounce of water
- 0.001 liter of water

Milliliter =
- 1.0 cubic centimeter
- 1 gram of water

Ounce (weight) =
- 0.063 pound
- 28.35 grams
- 0.96 fluid ounce of water

Pint =
- 16 fluid ounces
- ½ or 0.5 quart
- 0.13 gallon
- 1.04 pounds of water
- 473 milliliters

Pound =
- 16 ounces
- 454 grams
- 0.45 kilogram

Quart =
- 32 fluid ounces
- 4 cups
- 2 pints
- ¼ or 0.25 gallon
- 946 milliliters

Tablespoon =
- 3 teaspoons
- ½ or 0.5 fluid ounce
- 14.8 milliliters

Teaspoon =
- 0.33 tablespoon
- 0.17 fluid ounce
- 4.9 milliliters

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**FISH AND WILDLIFE SERVICE**

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